IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

ZAVALA LICENSING LLC,	§	
	§	
Plaintiff,	§	Case No:
	§	
vs.	§	PATENT CASE
	§	
THALES USA, INC.	§	
	§	
Defendant.	§	
	§	

COMPLAINT

Plaintiff Zavala Licensing LLC ("Plaintiff" or "Zavala") files this Complaint against Thales USA, Inc. ("Defendant" or "Thales") for infringement of United States Patent No. 6,684,086 (hereinafter "the '086 Patent").

PARTIES AND JURISDICTION

1. This is an action for patent infringement under Title 35 of the United States Code. Plaintiff is seeking injunctive relief as well as damages.

2. Jurisdiction is proper in this Court pursuant to 28 U.S.C. §§ 1331 (Federal Question) and 1338(a) (Patents) because this is a civil action for patent infringement arising under the United States patent statutes.

3. Plaintiff is a Texas limited liability company with its office address at 15922 Eldorado Pkwy, Ste 500, Frisco, TX 75035.

4. On information and belief, Defendant is a Delaware corporation with a principal address 2733 S. Crystal Drive, Suite 1200, Arlington, VA 22202. 5. On information and belief, this Court has personal jurisdiction over Defendant because Defendant has committed, and continues to commit, acts of infringement in this District, has conducted business in this

District, and/or has engaged in continuous and systematic activities in this District.

6. On information and belief, Defendant's instrumentalities that are alleged herein to infringe were and continue to be used, imported, offered for sale, and/or sold in this District.

VENUE

7. Venue is proper in this District pursuant to 28 U.S.C. § 1400(b) because Defendant is deemed to reside in this District because Defendant is a Delaware corporation.

COUNT I
(INFRINGEMENT OF UNITED STATES PATENT NO. 6,684,086)

8. Plaintiff incorporates paragraphs 1 through 7 herein by reference.

9. This cause of action arises under the patent laws of the United States and, in particular, under 35 U.S.C. §§ 271, *et seq*.

10. Plaintiff is the owner by assignment of the '086 Patent with sole rights to enforce the '086 Patent and sue infringers.

11. A copy of the '086 Patent, titled "Radio Base Station Device and Radio Communication Method," is attached hereto as Exhibit A.

12. The '086 Patent is valid, enforceable, and was duly issued in full compliance with Title 35 of the United States Code.

13. On information and belief, Defendant has infringed and continues to infringe one or more claims, including at least Claims 1 and 9, of the '086 Patent by making, using (at least through internal testing), importing, selling, and/or offering for sale radio base station equipment and systems, which are covered by at least Claims 1 and 9 of the '086 Patent. Defendant has infringed and continues to infringe the '086 patent directly in violation of 35 U.S.C. § 271.

14. Defendant sells, offers to sell, and/or uses radio base station equipment including, without limitation, the NEXIUM Wireless LTE network solution, and any similar products

("Product"), which infringe at least Claims 1 and 9 of the '086 Patent. The Product comprises a radio base station apparatus (e.g., an LTE base station). Certain claim elements are illustrated in the publicly available information regarding the Product, as shown below:

Thales announces the commercial launch of NEXIUM Wireless, a new LTE network solution designed to provide very high data rate communication services to civil security forces as well as military units deployed in peacekeeping and civil defence roles. NEXIUM Wireless includes TeSquad, a ruggedised push-to-talk Android smartphone.

Professional mobile radio (PMR) users now require more effective, high-bandwidth multimedia capabilities to share information in the field (database look-up, real-time video, situational awareness, image transfer, geolocation, etc.).

The new NEXIUM Wireless solution from Thales brings professional users the benefits of 4th generation (4G) LTE technology, building on Thales's expertise in mission-critical communications to provide the resilience and security levels needed to meet the specific operational requirements of its customers.

https://www.thalesgroup.com/en/worldwide/press-release/nexium-wireless-new-lte-network-solution

NEXIUM WIRELESS

Highly resilient and secure
Thales's trusted security solutions provide greater resiliency and stronger protection than commercial LTE solutions.

The mission-critical PMR broadband solution
Features such as push-to-talk, scalable capacity and deployment flexibility are ideally suited to the requirements of public safety, military and private networks.

S-MVNO
Thales provides the technology and tools to securely deploy and run a Mobile Virtual Network Operator on top of commercial network operators. This allows our customers to benefit from already deployed 3G/4G networks while deploying their own dedicated infrastructure for critical areas.

lte

KEEPING IN HAND ALL CRITICAL FUNCTIONS

- PMR services over LTE, including TETRA-like push-to-talk
- Enhanced with high data rate push-to-show: allowing multimedia group calls
- Video on-the-move, database remote access, location-based services, shared real time information, for mobile and Command & Control

DESIGNED FOR OPERATIONS

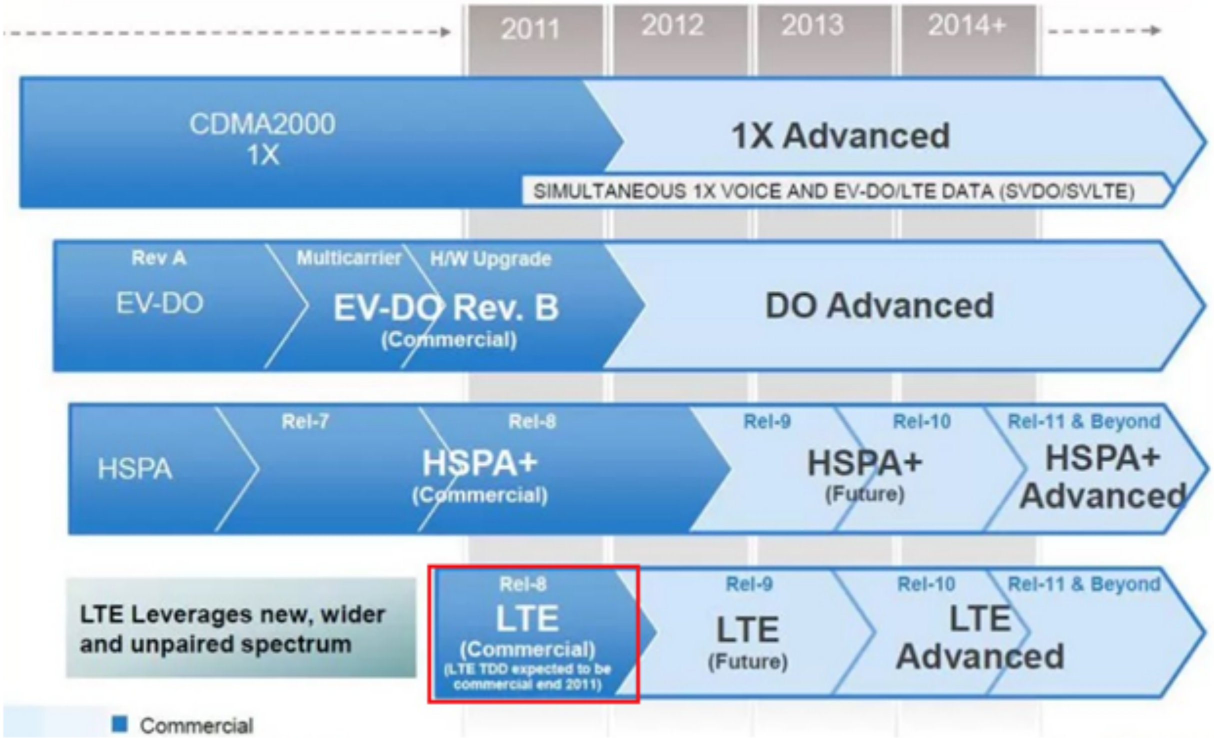
- Compact and flexible solution, deployable ranging from a single node to nationwide coverage
- Edge-centric system, which maintains communications by distributing intelligence towards each node of the network
- Highly resilient, no single point of failure

https://www.thalesgroup.com/sites/default/files/asset/document/nexium_wireless_4.pdf

https://www.thalesgroup.com/sites/default/files/asset/document/nexium_wireless_4.pdf

Release	Event	Info
-	November 2004 - 3GPP began a project to define long-term evolution of UMTS cellular technology	-
3GPP Release 7	September 2005 - Stage 1 (freeze)	HSPA+ Standard
	September 2006 - Stage 2 (freeze)	
	December 2007 - Stage 3 (freeze)	
3GPP Release 8	March 2008 - Stage 1 (freeze)	LTE Standard
	June 2008 - Stage 2 (freeze)	
	December 2008 - Stage 3 (freeze)	
3GPP Release 9	December 2008 - Stage 1 (freeze)	SAE Enhancements, WiMAX and UMTS Interoperability
	June 2009 - Stage 2 (freeze)	
	December 2009 - Stage 3 (freeze)	
3GPP Release 10	In progress	LTE-Advanced

http://3gpplte-longtermevolution.blogspot.in/2010/06/classification-and-development-of-lte.html



https://lazure2.wordpress.com/mobile-internet-standards/

Release 8 - LTE Introduced

Release frozen in Dec 2008

It was 3GPP release 8 when LTE was introduced for the very first time. All the releases following only enhanced the technology.

Based on release 8 standardization, following were the main achievements

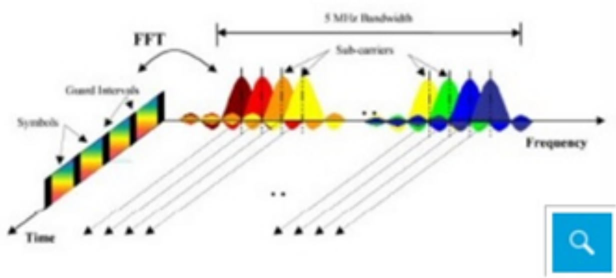
- High peak data rates : Up to 300 Mbps in downlink and 75 Mbps in uplink when using 4x4 MIMO and 20 MHz bandwidth
- High spectral efficiency
- Flexible bandwidths: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz
- Short round trip time: 5 ms latency for IP packets in ideal radio conditions
- Simplified Architecture
- OFDMA in downlink and SC-FDMA in uplink
- All IP network
- MIMO multiple antenna scheme
- Operation in paired (FDD) and unpaired spectrum (TDD)

http://www.simpletechpost.com/2015/02/overview-of-lte-3gpp-releases.html

The LTE technology as specified within 3GPP Release 8 was first commercially deployed by end 2009. Since then the number of commercial networks is strongly increasing around the globe. LTE has become the fastest developing mobile system technology. As other cellular technologies LTE is continuously worked on in terms of improvements. 3GPP groups added technology components into so called releases. Initial enhancements were included in 3GPP Release 9, followed by more significant improvements in 3GPP Release 10, also known as LTE-Advanced. Beyond

https://cdn.rohde-schwarz.com/pws/dl_downloads/dl_application/application_notes/1ma232/1MA232_1e_LTE_Rel11_technology.

LTE Fundamentals

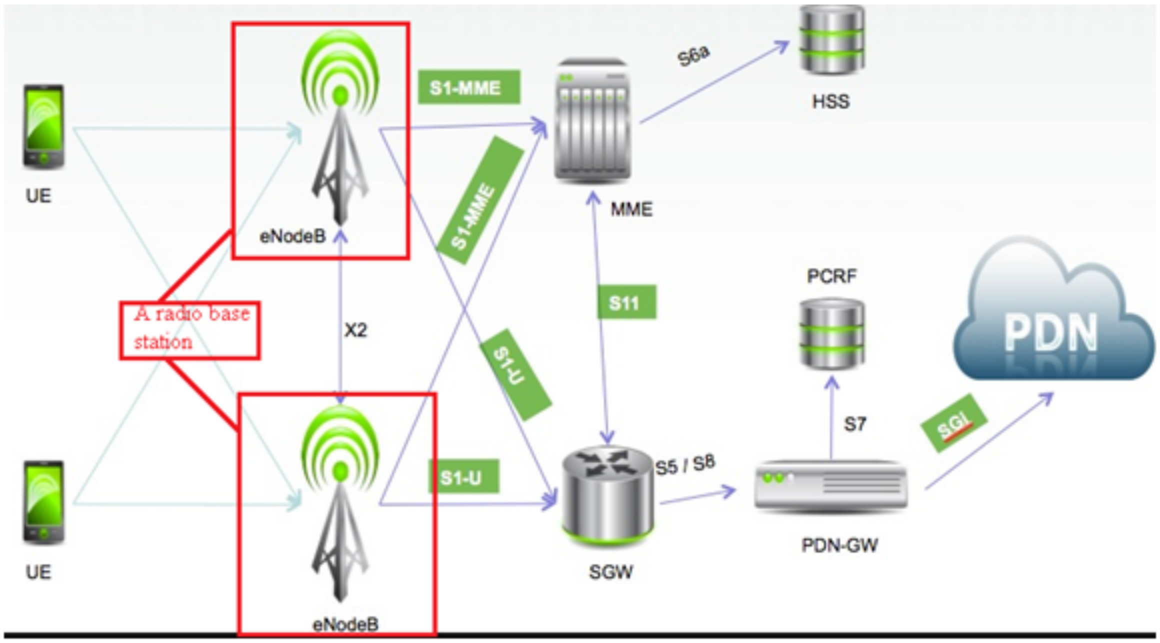


Long Term Evolution (LTE) will ensure the competitiveness of UMTS for the next ten years and beyond by providing a high-data rate, low-latency and packet-optimized system. Also known as E-UTRA (Evolved Universal Terrestrial Radio Access), LTE is part of 3GPP Release 8 specifications. LTE can be operated in either frequency division duplex (FDD) or time division duplex (TDD) mode, also referred to as LTE FDD and TD-LTE. The main key technology aspects of LTE are:

- New, Orthogonal Frequency Division Multiple Access (OFDMA) based multiple access schemes for both LTE FDD and TD-LTE
- Scalable bandwidth up to 20 MHz
- Support for Multiple Input Multiple Output (MIMO) antenna technology
- New data and control channels
- New network and protocol architecture (two node, IP based)

LTE (3GPP Release 8) supports theoretical peak data rates of 300Mbps in downlink and 75Mbps in uplink direction. The first commercial network was launched in Sweden in December 2009 whereas meanwhile LTE has become the fastest growing mobile communication technology ever. Commercially available end user devices support max. 100Mbps (DL) / 50Mbps(UL). Please note that achievable data rates in real life networks varies depending on e.g. network load and propagation conditions and is generally significantly lower than the maximum rates achieved in test lab environment.

https://www.rohde-schwarz.com/us/technologies/cellular/lte/lte-technology/lte_information_52292.html



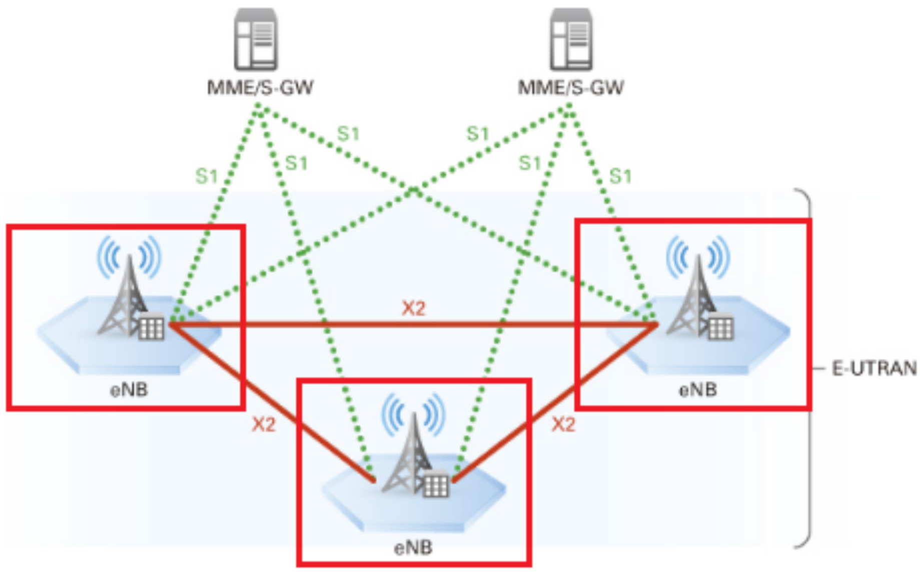
https://penturalabs.files.wordpress.com/2013/12/lte-network-diagram.png

What is the LTE eNodeB?

One of the biggest differences between LTE networks and legacy 3G mobile communication systems is the base station. In 3G systems, there is an intelligent and centralizing node like the RNC (Radio Network Controller), and it needs to control all the radio resources and mobility over multiple NodeBs (3G base stations) underneath it in a hieratical radio access network (Figure 1). All NodeBs need to do is behave exactly according to commands from the RNC sent over the Iub interface. In LTE, on the other hand, eNBs (evolved NodeBs) as base stations have to manage radio resource and mobility in the cell and sector to optimize all the UE's communication in a flat radio network structure (Figure 2). Therefore, the performance of an LTE eNB depends on its radio resource management algorithm and its implementation.

http://www.artizanetworks.com/resources/tutorials/what_lteenb.html

Figure 2 : E-UTRAN Architecture



http://www.artizanetworks.com/resources/tutorials/what_lteenb.html

LTE eNB Functions

According to the 3GPP Release 8 overview, the eNB hosts the following functions within an LTE network:

- **Radio Resource Management**
  - » Radio Bearer Control
  - » Radio Admission Control
  - » Connection Mobility Control
  - » Dynamic allocation of resources to UEs in both uplink and downlink (scheduling)

http://www.artizanetworks.com/resources/tutorials/fuc.html

15. The Product comprises an estimation section (e.g., a processing block) that estimates arrival directions of receiving signals (e.g., direction of received uplink signal) from a plurality of communication terminals (e.g., mobiles, smartphones, tablets, etc.). Upon information and belief the Product comprises an estimation section (e.g., a processing block) to

calculate direction of arrival by a user equipment specific reference signal from the user equipment (e.g., mobiles, smartphones, tablets, etc.). The base station estimates direction of arrival of receiving signal from a user equipment for optimum beamforming. These and other elements are illustrated in the publicly available information regarding the Product, as shown in connection with the above allegations and as further shown below:

3.2.7 TM 7 – Beamforming (antenna port 5)

This mode uses UE-specific reference signals (RS). Both the data and the RS are transmitted using the same antenna weightings. Because the UE requires only the UE-specific RS for demodulation of the PDSCH, the data transmission for the UE appears to have been received from only one transmit antenna, and the UE does not see the actual number of transmit antennas. Therefore, this transmission mode is also called "single antenna port; port 5". The transmission appears to be transmitted from a single "virtual" antenna port 5.

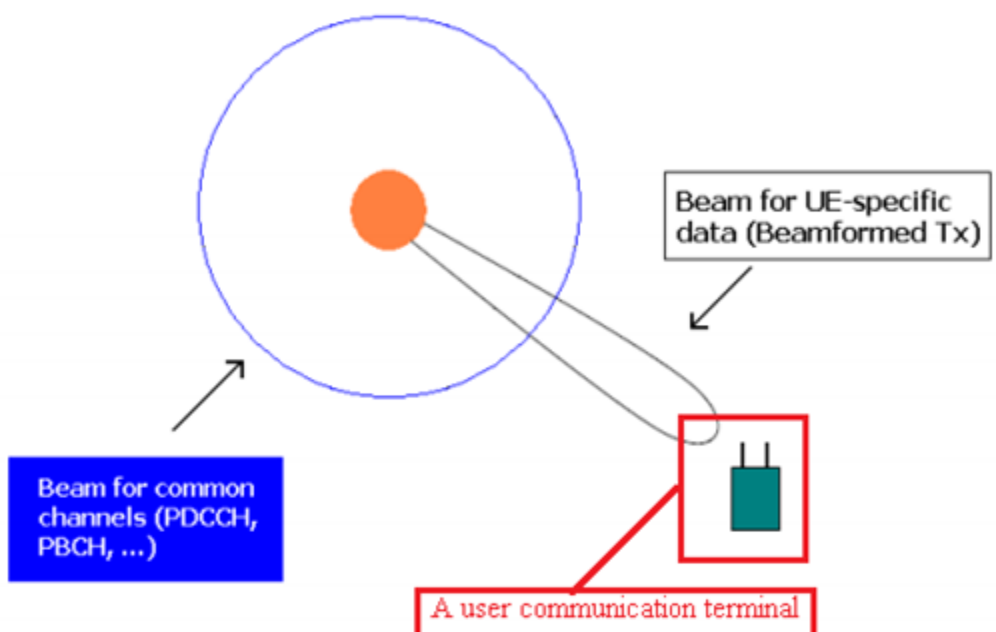


Figure 14: Beamforming in TM 7; use of UE-specific RS; the common channels use transmit diversity

There are different algorithms for calculating the optimum beamforming weightings. For example, it is possible to determine the direction of the received uplink signal (DoA or angle of arrival (AoA)), and from that calculate the beamforming weightings. However, this requires an antenna array with a distance between the individual antenna elements of **d ≤ λ/2**. It can be difficult to determine the DoA if the angular spread is not small or if there is no dominant direction in the DoA.

http://www.3g4g.co.uk/Lte/LTE_WP_1110_RandS.pdf

http://www.3g4g.co.uk/Lte/LTE_WP_1110_RandS.pdf

3) Adaptive Beamforming: Adaptive beamforming uses antenna elements with a narrow antenna spacing of about half the carrier wavelength and it has been studied for use with base stations with the antennas mounted in a high location. In this case beamforming is performed by exploiting the UE Direction of Arrival (DoA) or the channel covariance matrix estimated from the uplink, and the resulting transmit weights are not selected from a codebook. In LTE Rel. 8, a UE-specific RS is defined for channel estimation in order to support adaptive beamforming. Unlike the cell-specific RS,

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http://blog.3g4g.co.uk/2011/03/quick-recap-of-mimo-in-lte-and-lte.html

Function	Implementation
PHY/ Baseband	FPGAs/ASSPs
Lower layer protocol	DSPs/Network processor
PDCP and upper layer protocols	CPUs/Network processor with operation system

eNodeB vendors can minimize their development efforts by using generic components, not only in terms of hardware modules but also in terms of intellectual property like baseband logical circuits on FPGAs, protocol stack software, etc. The figures below show examples of LTE eNB implementation on a Micro-TCA platform.

http://www.artizanetworks.com/resources/tutorials/arc.html

The LTE system targets for high data rate, high system capacity and large coverage to provide excellent user experience. Beamforming (BF) is one of the technologies helping to reach this goal, specifically by improving the cell edge performance. LTE as specified in 3GPP Release 8 already supports single-layer beamforming based on user-specific Reference Symbols (also referred to as Dedicated RS or DRS or DM RS). Single-layer beamfroming uses only one codeword, i.e. one transport block. In general the solution allows to direct the beam towards a specific UE through position estimation at the eNodeB (direction of arrival). The eNodeB generates a beam using the array of antenna elements, and then applies the same precoding to both the data payload and the UE-specific reference signal with this beam. It is important to note that the UE-specific reference signal is transmitted in a way such that its time-frequency location does not overlap with the cell-specific reference signal. As the scheme is not involving any UE feedback mechanism, it is specifically suited for LTE in TDD mode of operation, leveraging the reciprocity of the propagation channel in DL and UL direction.

https://cdn.rohde-schwarz.com/pws/dl_downloads/dl_application/application_notes/1ma191/1MA191_0E_LTE_release_9_technolo

gy.pdf

6.10.3 UE-specific reference signals

UE-specific reference signals are supported for single-antenna-port transmission of PDSCH and are transmitted on antenna port 5. The UE is informed by higher layers whether the UE-specific reference signal is present and is a valid reference for PDSCH demodulation or not. UE-specific reference signals are transmitted only on the resource blocks upon which the corresponding PDSCH is mapped. The UE-specific reference signal is not transmitted in resource elements (k,l) in which one of the physical channels or physical signals other than UE-specific reference signal defined in 6.1 are transmitted using resource elements with the same index pair (k,l) regardless of their antenna port p.

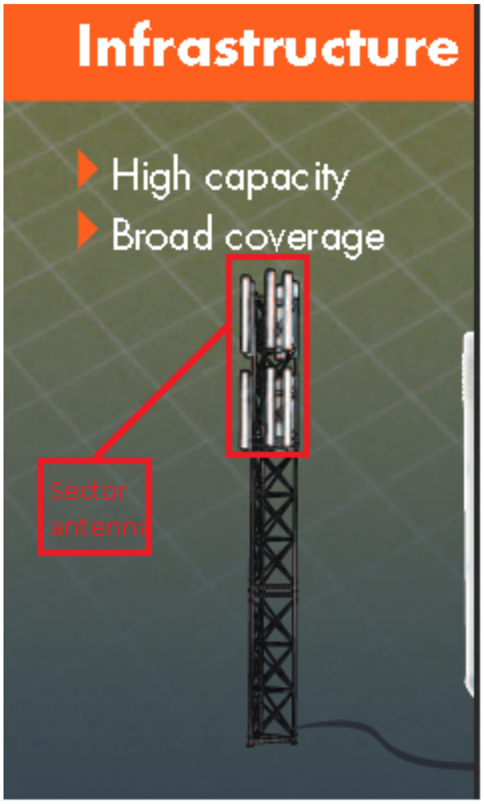
http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf

16. The Product comprises a group dividing section (e.g., a processing unit) that divides the plurality of communication terminals (e.g., mobiles, smartphones, tablets, etc.) into a plurality of groups (e.g., dividing mobiles into different sectors within a cell), based on the estimated arrival directions of the receiving signals. The base station selects a specific sector antenna for a mobile if the direction of arrival of a reference signal from the mobile lies in the sector of that antenna. This is illustrated in the publicly available information above and additional information below:

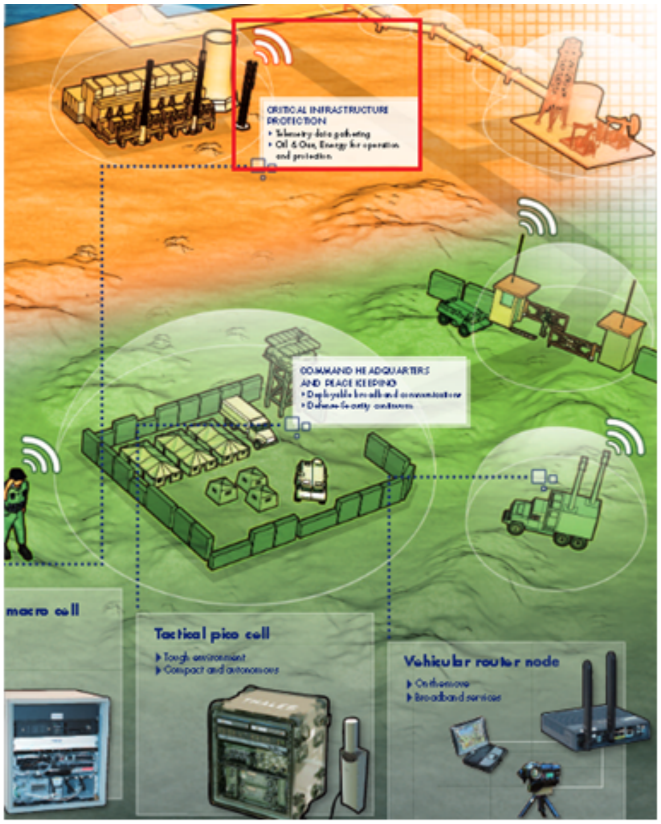
Function	Implementation
PHY/ Baseband	FPGAs/ASSPs
Lower layer protocol	DSPs/Network processor
PDCP and upper layer protocols	CPUs/Network processor with operation system

eNodeB vendors can minimize their development efforts by using generic components, not only in terms of hardware modules but also in terms of intellectual property like baseband logical circuits on FPGAs, protocol stack software, etc. The figures below show examples of LTE eNB implementation on a Micro-TCA platform.

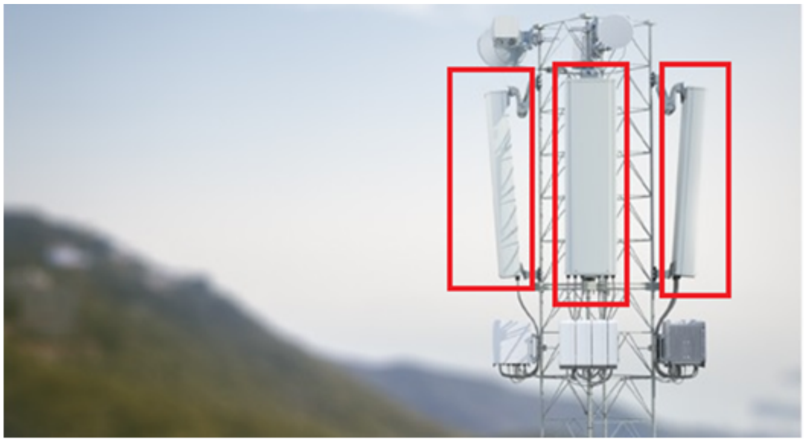
http://www.artizanetworks.com/resources/tutorials/arc.html



https://www.thalesgroup.com/sites/default/files/asset/document/nexium_wireless_4.pdf



https://www.thalesgroup.com/sites/default/files/asset/document/thales_3volets_pmr_nexium_wireless_20132510.pdf



GLOBAL LTE BASE STATION MARKET TO REACH $6.37 BILLION IN 2013

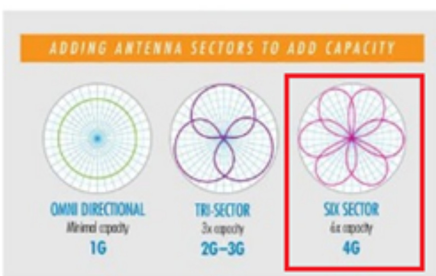
Tuesday 5 March 2013, Amsterdam

Our latest report Global LTE Base Station Market 2013-2018: The Next Generation Infrastructure for 4G Mobile Telecommunications examines the LTE base station market with a focus on leading vendors, prosperous regions, impending network transformation projects, and central technologies.

As data traffic grows exponentially a rapid shift network shift to LTE and 4G will have to occur to cope. The introduction of superphones and tablets has saturated the mobile market, and the introduction of new, faster network technologies has become a matter of adapt-or-perish. Having a robust and practicable LTE strategy is what will separate today's incumbent operators from tomorrow's.

Cellular base stations are the last link between the core network and the end-user's device. As such, their interoperability and interaction must provide a high-speed, high-quality, low-latency service to which customers are rapidly growing accustomed. In addition, operators in competitive markets seeking to minimise costs will seek out options that are compact, easy to install, require little maintenance, and are power efficient. As operators rocket towards trials and deployments, infrastructure vendors that have readily available LTE base stations meeting a variety of exacting standards will prevail.

https://www.asdreports.com/news-1202/global-lte-base-station-market-reach-637-billion-2013



However, this cells and sectors terminology will be challenged as the industry deploys new antenna technology for systems like LTE and 4G. The idea of optimizing coverage and capacity with the antenna system relies on focusing the beam in select areas and adapting to a user's equipment—that by nature are not located uniformly. **Uniform distribution** of a user's equipment would clearly support the concept of the same cell size and structure of the hexagon honeycomb. However, with technologies such as **beam tilt**, the beams are adjusted to be different sizes and direction to support the actual user patterns. Technologies such as **multi beam** (as used in six-sector deployments), **adaptive array**, and **active antennas**, allow the antenna's coverage area to be shaped and formed to fit the capacity and coverage requirements of users. For example, a six-sector deployment is, in effect, two sectors per cell, or is it?

http://www.commscope.com/Blog/Cells--Sectors-and-Antenna-Beamforming/

4.2.1.1 BS antenna radiation pattern

The BS antenna radiation pattern to be used for each sector in 3-sector cell sites is plotted in Figure 4.1. The pattern is identical to those defined in [1], [2] and [4]:

$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right] \quad \text{where } -180 \le \theta \le 180,$$

θ_{3dB} is the 3dB beam width which corresponds to 65 degrees, and $A_m = 20dB$ is the maximum attenuation

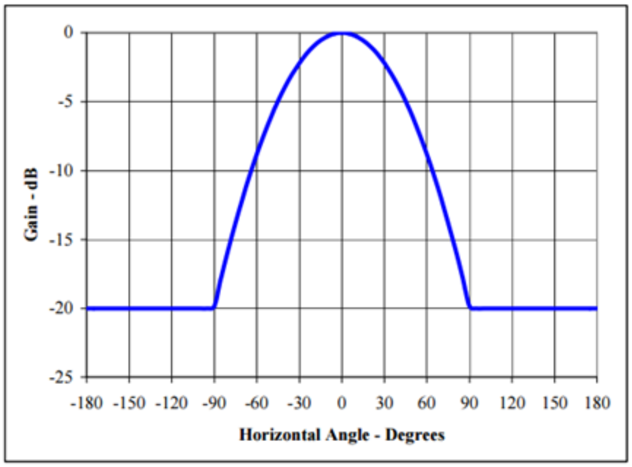


Figure 4.1: Antenna Pattern for 3-Sector Cells

http://www.etsi.org/deliver/etsi_tr/136900_136999/136942/08.02.00_60/tr_136942v080200p.pdf

Considering beam forming function of smart antenna, the following five basic beam forming pattern is provided with their main beam pointing to 0°,30°,45°,60° and 70° respectively. The beam patterns pointing to -30°,-45°,-60° and -70° can be derived through the image of the above beam patterns. Thus, we can get nine angles beamforming radioation pattern. The gain of blow -90 and above 90 is assumed as -∞ by using the ideal isolation. In the simulation each UE will select the most adjacent (in angle) beam pattern for signal strength and interference calculation accroding the the angle calculated from the UE position and BS sector antenna direction. For example if a UE "s angle to the direction of the sector is 25^0, the 30^0 beam pattern will be selected. Then the selected beam pattern will be shifted -5^0, by which the main beam will pointing the UE. The signal strengh and interference from different direction will be calculated based on the shifted pattern. The shifted angle out of [-90°,90°] will be transfered inside [-90°,90°] by horizontal imaging.

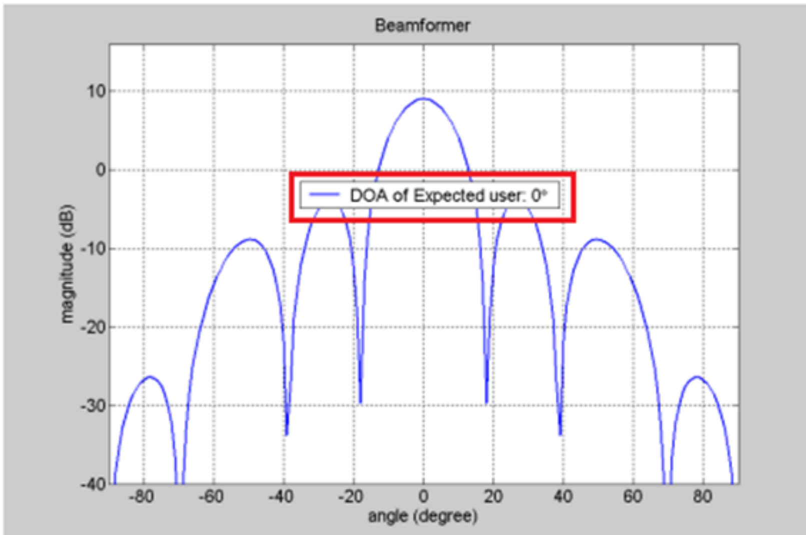


Figure B.1: 0° beam forming pattern

http://www.etsi.org/deliver/etsi_tr/136900_136999/136942/08.04.00_60/tr_136942v080400p.pdf

17. The Product comprises an assignment control section (e.g., a scrambling sequence generator block) that assigns a same scramble code to all communication terminals (e.g., mobiles, smartphones, tablets, etc.) belonging under a same group (e.g., mobiles under a sector of a cell). The scrambling sequence depends upon the initialization value of the scrambling sequence, which is calculated on basis of the physical layer cell identity of the base station. The physical layer cell identity determines cell ID group and cell ID sector. This is illustrated in the publicly available information above and the additional information below:

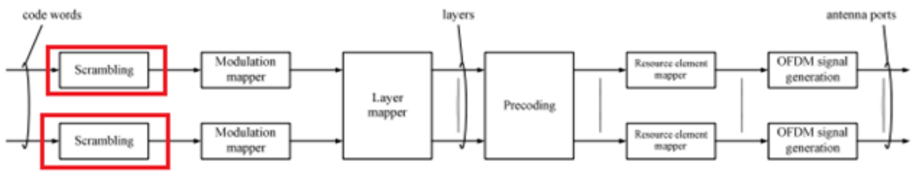


Figure 6.3-1: Overview of physical channel processing.

6.3.1 Scrambling

For each code word q, the block of bits $b^{(q)}(0),...,b^{(q)}(M_{\text{bit}}^{(q)}-1)$, where $M_{\text{bit}}^{(q)}$ is the number of bits in code word q transmitted on the physical channel in one subframe, shall be scrambled prior to modulation, resulting in a block of scrambled bits $\tilde{b}^{(q)}(0),...,\tilde{b}^{(q)}(M_{\text{bit}}^{(q)}-1)$ according to

$$\tilde{b}^{q}(i) = \left(b^{q}(i) + c^{q}(i)\right) \bmod 2$$

where the scrambling sequence $c^{q}(i)$ is given by Section 7.2. The scrambling sequence generator shall be initialised at the start of each subframe, where the initialisation value of c_{init} depends on the transport channel type according to

$$c_{\text{init}} = \begin{cases} n_{\text{RNTI}} \cdot 2^{14} + q \cdot 2^{13} + \lfloor n_s/2 \rfloor \cdot 2^{9} + N_{\text{ID}}^{\text{cell}} & \text{for PDSCH} \\ \lfloor n_s/2 \rfloor \cdot 2^{9} + N_{\text{ID}}^{\text{MBSFN}} & \text{for PMCH} \end{cases}$$

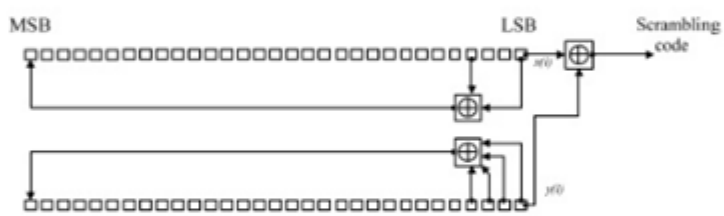
where n_{RNTI} corresponds to the RNTI associated with the PDSCH transmission as described in Section 7.1[4].

Up to two code words can be transmitted in one subframe, i.e., $q \in \{0,1\}$. In the case of single code word transmission, q is equal to zero.

http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf

Scrambling

- Sequence generation
  - The scrambling sequence generator shall be initialised at the start of each subframe, where the initialisation value of c_{init}
- Generation register
  - Fill the top register with the following fixed pattern x(0)=1(MSB),and x(1)=…=x(30)=0.
  - Fill the lower register with the initialisation sequence based on below



- PDSCH & PMCH: $c_{\text{init}} = \begin{cases} n_{\text{RNTI}} \cdot 2^{14} + q \cdot 2^{13} + (n_s/2) \cdot 2^{9} + N_{\text{ID}}^{\text{cell}} & \text{for PDSCH} \\ (n_s/2) \cdot 2^{9} + N_{\text{ID}}^{\text{MBSFN}} & \text{for PMCH} \end{cases}$
- PBCH: $c_{\text{init}} = N_{\text{ID}}^{\text{cell}}$ (Re-initialization is performed every 4 subframes)
- PCFICH, PDCCH, PHICH: $c_{\text{init}} = (n_s/2) \cdot 2^{9} + N_{\text{ID}}^{\text{cell}}$

https://www.slideshare.net/allabout4g/lte-rel-8-physical-layer

6.3 General structure for downlink physical channels

This section describes a general structure, applicable to more than one physical channel.

The baseband signal representing a downlink physical channel is defined in terms of the following steps:

- scrambling of coded bits in each of the code words to be transmitted on a physical channel
- modulation of scrambled bits to generate complex-valued modulation symbols
- mapping of the complex-valued modulation symbols onto one or several transmission layers
- precoding of the complex-valued modulation symbols on each layer for transmission on the antenna ports
- mapping of complex-valued modulation symbols for each antenna port to resource elements
- generation of complex-valued time-domain OFDM signal for each antenna port

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http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf

$N_{\mathrm{RB}}^{(2)}$	Bandwidth available for use by PUCCH formats 2/2a/2b, expressed in multiples of $N_{\mathrm{sc}}^{\mathrm{RB}}$
$N_{\mathrm{RB}}^{\mathrm{HO}}$	The offset used for PUSCH frequency hopping, expressed in number of resource blocks (set by higher layers)
$N_{\mathrm{ID}}^{\mathrm{cell}}$	Physical layer cell identity
$N_{\mathrm{ID}}^{\mathrm{MBSFN}}$	MBSFN area identity
$N_{\mathrm{RB}}^{\mathrm{DL}}$	Downlink bandwidth configuration, expressed in multiples of $N_{\mathrm{sc}}^{\mathrm{RB}}$

http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf

There are 504 unique physical-layer cell identities. The physical-layer cell identities are grouped into 168 unique physical-layer cell-identity groups, each group containing three unique identities. The grouping is such that each physical-layer cell identity is part of one and only one physical-layer cell-identity group. A physical-layer cell identity $N_{\mathrm{ID}}^{\mathrm{cell}} = 3N_{\mathrm{ID}}^{(1)} + N_{\mathrm{ID}}^{(2)}$ is thus uniquely defined by a number $N_{\mathrm{ID}}^{(1)}$ in the range of 0 to 167, representing the physical-layer cell-identity group, and a number $N_{\mathrm{ID}}^{(2)}$ in the range of 0 to 2, representing the physical-layer identity within the physical-layer cell-identity group.

http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.09.00_60/ts_136211v080900p.pdf

http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.09.00_60/ts_136211v080900p.pdf

Cell ID (LTE)

Menu Path: **MeasSetup** > **LTE Demod Properties...** > **Format tab**

Default: Auto
Range: Auto, Manual: 0-503

Cell ID sets the physical (PHY) layer Cell ID. This PHY-layer Cell ID determines the Cell ID Group and Cell ID Sector. There are 168 possible Cell ID groups and 3 possible Cell ID sectors; therefore, there are 3 * 168 = 504 possible PHY-layer cell IDs. When **Cell ID** is set to **Auto**, the demodulator will automatically detect the Cell ID. When **Cell ID** is set to **Manual**, the PHY-layer Cell ID must be specified for successful demodulation.

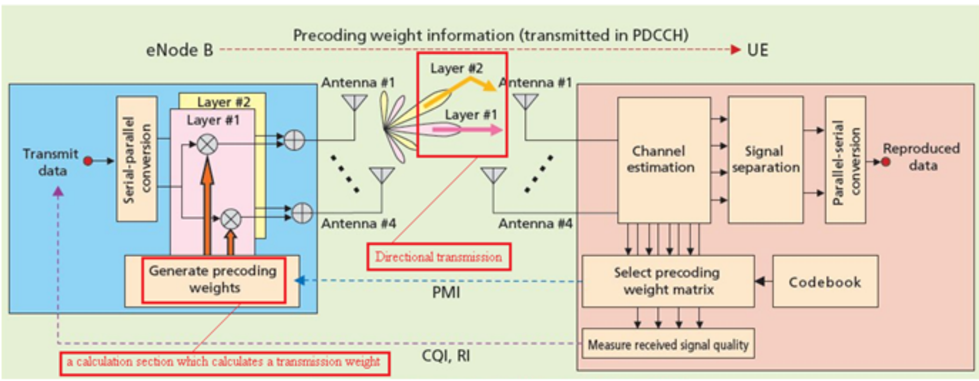
The physical layer cell id can be calculated from the following formula:

```
PHY-layer Cell ID = 3*(Cell ID Group) + Cell ID Sector
```

http://rfmw.em.keysight.com/wireless/helpfiles/89600b/webhelp/subsystems/lte/content/lte_dlg_fmt_cellid.htm

18. The Product comprises a calculation section (e.g., a precoding weights generating

block) that calculates a transmission weight (e.g., a precoding weight) to perform directional transmission (e.g., user equipment specific beamforming) to the plurality of communication terminals (e.g., mobiles, smartphones, tablets, etc.). This is illustrated in the publicly available information above and the additional information below:



http://1.bp.blogspot.com/-ULXNHVGI90w/TZBa9fQZJqI/AAAAAAAADGs/TOiOGGN64lc/s1600/MIMO_NttDocomo_1.jpg

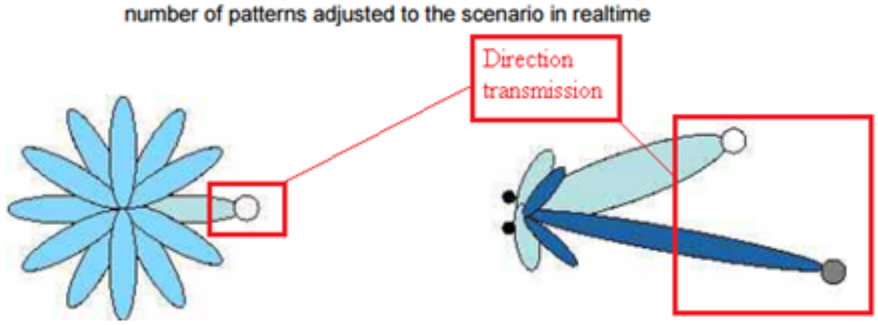
Beamforming

Antenna technologies are the key in increasing network capacity. It started with sectorized antennas. These antennas illuminate 60 or 120 degrees and operate as one cell. In GSM, the capacity can be tripled, by 120 degree antennas. Adaptive antenna arrays intensify spatial multiplexing using narrow beams. Smart antennas belong to adaptive antenna arrays but differ in their smart direction of arrival (DoA) estimation. Smart antennas can form a user-specific beam. Optional feedback can reduce complexity of the array system.

Beamforming is the method used to create the radiation pattern of an antenna array. It can be applied in all antenna array systems as well as MIMO systems.

Smart antennas are divided into two groups:

- Phased array systems (switched beamforming) with a finite number of fixed predefined patterns
- Adaptive array systems (AAS) (adaptive beamforming) with an infinite number of patterns adjusted to the scenario in realtime



https://cdn.rohde-

schwarz.com/pws/dl_downloads/dl_application/application_notes/1ma142/1MA142_0e_introduction_to_MIMO.pdf

3.1.2 LTE (3GPP Release 8)

UMTS Long Term Evolution (LTE) was introduced in 3GPP Release 8. The objective is a high data rate, low latency and packet optimized radio access technology. LTE is also referred to as E-UTRA (Evolved UMTS Terrestrial Radio Access) or E-UTRAN (Evolved UMTS Terrestrial Radio Access Network).

The basic concept for LTE in downlink is OFDMA (Uplink: SC-FDMA), while MIMO technologies are an integral part of LTE. Modulation modes are QPSK, 16QAM, and 64QAM. Peak data rates of up to 300 Mbps (4x4 MIMO) and up to 150 Mbps (2x2 MIMO) in the downlink and up to 75 Mbps in the uplink are specified.

For an introduction to LTE, refer to [2] [3] [4]. For more information on MIMO in LTE, refer to [6].

Downlink

The following transmission modes are possible in LTE:

- Single antenna transmission, no MIMO
- Transmit diversity
- Open-loop spatial multiplexing, no UE feedback required
- Closed-loop spatial multiplexing, UE feedback required
- Multi-user MIMO (more than one UE is assigned to the same resource block)
- Closed-loop precoding for rank=1 (i.e., no spatial multiplexing, but precoding is used)
- Beamforming

https://cdn.rohde-schwarz.com/pws/dl_downloads/dl_application/application_notes/1ma142/1MA142_0e_introduction_to_MIMO.pdf

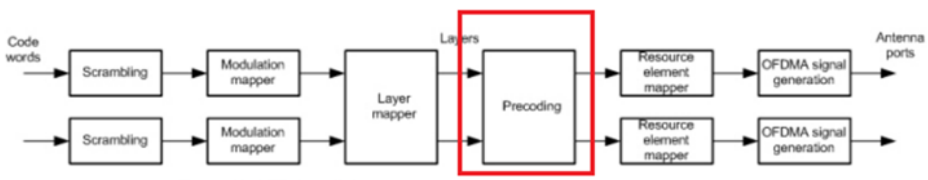


Figure 12: LTE downlink

https://cdn.rohde-schwarz.com/pws/dl_downloads/dl_application/application_notes/1ma142/1MA142_0e_introduction_to_MIMO.pdf

6.3.4 Precoding

The precoder takes as input a block of vectors $x(i) = \left[x^{(0)}(i) \ \ldots \ x^{(\upsilon-1)}(i)\right]^T$, $i = 0,1,\ldots,M_{\text{symb}}^{\text{layer}} - 1$ from the layer mapping and generates a block of vectors $y(i) = \left[\ldots \ y^{(p)}(i) \ \ldots\right]^T$, $i = 0,1,\ldots,M_{\text{symb}}^{\text{ap}} - 1$ to be mapped onto resources on each of the antenna ports, where $y^{(p)}(i)$ represents the signal for antenna port p.

6.3.4.1 Precoding for transmission on a single antenna port

For transmission on a single antenna port, precoding is defined by

$$y^{(p)}(i) = x^{(0)}(i)$$

where $p \in \{0,4,5\}$ is the number of the single antenna port used for transmission of the physical channel and $i = 0,1,\ldots,M_{\text{symb}}^{\text{ap}} - 1$, $M_{\text{symb}}^{\text{ap}} = M_{\text{symb}}^{\text{layer}}$.

6.3.4.2 Precoding for spatial multiplexing

Precoding for spatial multiplexing is only used in combination with layer mapping for spatial multiplexing as described in Section 6.3.3.2. Spatial multiplexing supports two or four antenna ports and the set of antenna ports used is $p \in \{0,1\}$ or $p \in \{0,1,2,3\}$, respectively.

6.3.4.2.1 Precoding without CDD

Without cyclic delay diversity (CDD), precoding for spatial multiplexing is defined by

$$\begin{bmatrix} y^{(0)}(i) \\ \vdots \\ y^{(P-1)}(i) \end{bmatrix} = W(i) \begin{bmatrix} x^{(0)}(i) \\ \vdots \\ x^{(\upsilon-1)}(i) \end{bmatrix}$$

where the precoding matrix $W(i)$ is of size $P \times \upsilon$ and $i = 0,1,\ldots,M_{\text{symb}}^{\text{ap}} - 1$, $M_{\text{symb}}^{\text{ap}} = M_{\text{symb}}^{\text{layer}}$.

For spatial multiplexing, the values of $W(i)$ shall be selected among the precoder elements in the codebook configured in the eNodeB and the UE. The eNodeB can further confine the precoder selection in the UE to a subset of the elements in the codebook using codebook subset restrictions. The configured codebook shall be selected from Table 6.3.4.2.3-1 or 6.3.4.2.3-2.

6.3.4.2.2 Precoding for large delay CDD

For large-delay CDD, precoding for spatial multiplexing is defined by

$$\begin{bmatrix} y^{(0)}(i) \\ \vdots \\ y^{(P-1)}(i) \end{bmatrix} = W(i)D(i)U \begin{bmatrix} x^{(0)}(i) \\ \vdots \\ x^{(\upsilon-1)}(i) \end{bmatrix}$$

where the precoding matrix $W(i)$ is of size $P \times \upsilon$ and $i = 0,1,\ldots,M_{\text{symb}}^{\text{ap}} - 1$, $M_{\text{symb}}^{\text{ap}} = M_{\text{symb}}^{\text{layer}}$. The diagonal size-$\upsilon \times \upsilon$ matrix $D(i)$ supporting cyclic delay diversity and the size-$\upsilon \times \upsilon$ matrix U are both given by Table 6.3.4.2.2-1 for different numbers of layers υ.

http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf

19. The Product comprises a directional transmission section (e.g., antenna section) that directionally transmits (e.g., user specific beamforming) a transmission signal modulated with the assigned scramble code (e.g., an OFDM signal), using the calculated transmission weight (e.g., determined precode). The accused product modulates the scrambled transmission signals (e.g., code words) and also comprises a directional transmission section (e.g., antenna section) which directionally transmits (e.g., a user specific beamforming) the modulated signal to the plurality of communication terminals (e.g., mobiles, smartphones, tablets, etc.) using the calculated transmission weight (e.g., determined precode). This is illustrated in the publicly available information above and the additional information below:

6.3 General structure for downlink physical channels

This section describes a general structure, applicable to more than one physical channel.

The baseband signal representing a downlink physical channel is defined in terms of the following steps:

- scrambling of coded bits in each of the code words to be transmitted on a physical channel
- modulation of scrambled bits to generate complex-valued modulation symbols
- mapping of the complex-valued modulation symbols onto one or several transmission layers
- precoding of the complex-valued modulation symbols on each layer for transmission on the antenna ports
- mapping of complex-valued modulation symbols for each antenna port to resource elements
- generation of complex-valued time-domain OFDM signal for each antenna port

http://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf

20. The Product comprises a calculation section (e.g., a precoding calculation section) calculates the transmission weight (e.g., a precode) that is common to all the communication terminals (e.g., mobiles, smartphones, tablets, etc.) belonging under the same group (e.g., mobiles under a sector of a cell).

21. The Product comprises a directional transmission section (e.g., antenna section) that performs transmission with a same directivity (e.g., user-specific beamforming) to all the communication terminals (e.g., mobiles, smartphones, tablets, etc.) belonging under the same group (e.g., mobiles under a sector of a cell).

22. Regarding Claim 9, the Product The accused product (e.g., LTE base station) practices a radio communication (e.g., cellular communication) method. The Product practices estimating arrival directions of receiving signals (e.g., direction of received uplink signal) from a plurality of communication terminals (e.g., mobiles, smartphones, tablets, etc.). The base station estimates direction of arrival of receiving signal from a user equipment for optimum beamforming. The Product practices dividing the plurality of communication terminals into a plurality of groups (e.g., dividing mobiles into different sectors within a cell), based on the estimated arrival directions of the receiving signals. The base station selects a specific sector

antenna for a mobile, if the direction of arrival of reference signal from the mobile lies in the sector of that antenna. The Product practices assigning a same scramble code to all communication terminals belonging under a same group (e.g., mobiles under a sector of a cell). Upon information and belief, the accused product practices assigning, by an assignment control section (e.g., a scrambling sequence generator block), which assigns a same scramble code to all communication terminals belonging under a same group. The scrambling sequence depends upon the initialization value of the scrambling sequence, which is calculated on basis of the physical layer cell identity of the base station. The physical layer cell identity determines cell ID group and cell ID sector. The accused product practices calculating a transmission weight (e.g., a precoding weight) to perform directional transmission (e.g., user equipment specific beamforming) to the plurality of communication terminals (e.g., mobiles, smartphones, tablets, etc.). The Product practices directionally transmitting (e.g., user specific beamforming) a transmission signal modulated with the assigned scramble code (e.g., an OFDM signal), using the calculated transmission weight (e.g., determined precode). The Product modulates the scrambled transmission signals (e.g., code words) and also comprises a directional transmission section (e.g., antenna section) which directionally transmits (e.g., a user specific beamforming) the modulated signal to the plurality of communication terminals (e.g., mobiles, smartphones, tablets) using the calculated transmission weight (e.g., determined precode). The Product practices, in the transmission weight calculation step, the calculated transmission weight (e.g., a precode) that is common to all the communication terminals belonging under the same group. The Product practices in the directional transmission step, transmission is performed with a same directivity (e.g., user-specific beamforming) to all the communication terminals belonging under the same group. These elements are further illustrated in the allegations above in connection

with Claim 1.

23. Defendant's actions complained of herein will continue unless Defendant is enjoined by this court.

24. Defendant's actions complained of herein are causing irreparable harm and monetary damage to Plaintiff and will continue to do so unless and until Defendant is enjoined and restrained by this Court.

25. Plaintiff is in compliance with 35 U.S.C. § 287.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff asks the Court to:

(a) Enter judgment for Plaintiff on this Complaint on all causes of action asserted herein;

(b) Enter an Order enjoining Defendant, its agents, officers, servants, employees, attorneys, and all persons in active concert or participation with Defendant who receive notice of the order from further infringement of United States Patent No. 6,684,086 (or, in the alternative, awarding Plaintiff a running royalty from the time of judgment going forward);

(c) Award Plaintiff damages resulting from Defendant's infringement in accordance with 35 U.S.C. § 284;

(d) Award Plaintiff pre-judgment and post-judgment interest and costs; and

(e) Award Plaintiff such further relief to which the Court finds Plaintiff entitled under law or equity.

Dated: October 11, 2017

Respectfully submitted,

/s/ Stamatios Stamoulis

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